REMARKS

With entry of the foregoing amendments, claims 1-8, 11, 13-20, 23, 25 and 26 are now pending in this application. In the prior office action, the Examiner rejected all of the claims. Claims 1, 13 and 25 have been amended with the features of claims 12 and 24 (now canceled). Claim 26 has been added. No new matter is introduced Reconsideration is respectfully requested.

Claim Rejections - 35 U.S.C. § 103

The Examiner rejected claims 1-8, 11-20 and 23-25 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 5,978,370 to Shively in view of U.S. Patent 6,417,944 to Lahat et al. By way of the foregoing amendments, Applicants respectfully traverse this rejection.

As discussed from the bottom of page 2 of the application, an all optical switch addresses the problem of electronic bandwidth, but has difficulty performing the logic needed to route packets or providing the memory required for packet buffering. Also, optical switches typically switch very slowly. In accordance with the present invention, an optical switch operates with a schedule which allows for much slower switching than would be required if the routing were directly determined by the input packets.

Specifically, the optical switch is operated with a schedule that is not directly determined by an input stream of data units (e.g., cells or packets) but which takes into account unbalance in traffic. When unbalanced traffic arrives at a packet switch, input queues can grow to become unbalanced. The present invention solves this problem by adapting the schedule of the optical switch in response to this growth in queues to correct this unbalance. Neither Shively nor Lahat discloses schedule adaptation of any kind.

In particular, claims 1, 13, and 25 as now amended each recite a structure or step for "changing the schedule of the optical switch to have unbalanced periods in response to unbalance in traffic, <u>the switch schedule being changed in response to information regarding the number of reordered data units in the queues for each input/output pair</u>." This indirect control, while still allowing response to unbalanced traffic, greatly simplifies the task of switch scheduling and

control and is a major improvement over the prior art. Claims 1, 13 and 25 have also been amended to clarify the structure or steps involved in switching optical data streams.

For example, in the illustrated embodiment of Fig. 2, an optical switch 114 is coupled to a set of optical inputs 113 and a set of optical outputs 107. A switch controller, such as a sequencer 115, operates the optical switch with a schedule not directly determined by an input stream of data units. In other words, the schedule is not determined by the particular ordering of data units within an optical input data stream 101. Figs. 4 and 5 illustrate an example in which the sequencer directs the optical switch to connect its inputs to its outputs using a schedule that connects each input to each output for equal amounts of time.

Reordering units, such as time-slot interchangers 111, rearrange the order of the data units within the input data streams to correspond to the schedule of the switch, thus allowing the packets to be appropriately matched to the switch schedule for appropriate routing. For example, in Fig. 2, optical data streams 101 are converted into electrical data streams 103 by electrical-optical converters 102. The data streams 103 are then received by the time-slot interchangers 111 that are coupled to the inputs of the optical switch 114 through electrical-optical converters 106. The time-slot interchangers 111 then buffer the individual data units of the input data streams 103 into queues for each input/output pair of the optical switch (e.g., FIFO queues 151-154 of Fig 8).

The interchangers 111, knowing the switch schedule in advance from the sequencer 115, schedule the packets to appear on a switch input during the time period when that input is connected to the desired output. This reordering of packets matches the connections provided by the optical switch 114 under the control of sequencer 115. For example, in Fig. 6, the time-slot interchanger 111 reorders the packets of input stream 201 so that all packets destined for the same output are consecutive and occupy a fixed time period on the reordered stream 202.

However, the switch can only achieve full throughput when each input carries an equal amount of traffic destined for each output. This is because the switch schedule shown in Figs. 4 and 5 is balanced, with each input connected to each output for equal amounts of time. If the input traffic is not balanced, one or more of the FIFOs in the interchanger may be overrun, resulting in loss of data.

To prevent queue overruns, the switch controller can change the schedule of the optical switch to have unbalanced periods in response to such unbalance in traffic. Specifically, <u>the switch schedule can be changed in response to information regarding the number of reordered data units in the queues for each input/output pair</u>. For example, unbalanced switch schedules such as the one shown in Fig. 7 can be generated automatically by examining the occupancy of each of the four FIFO queues in each of the four interchangers. When the occupancy of a FIFO exceeds a threshold, the interchanger finds another FIFO with the least occupancy and swaps outputs with the interchanger.

Neither Shively nor Lahat discloses operating an optical switch with a schedule that is not directly determined by an input stream of data units and then changing the schedule to have unbalanced periods in response to unbalance in traffic. Specifically, the switch schedule is changed in response to information regarding the number of reordered data units in the queues for each input/output pair as now recited in claims 1, 13 and 25.

Shively merely mentions that the schedule of its switch can be changed to accommodate different mixes of traffic with every call set-up/termination and to accommodate new equipment mixes added to the system. (See Shively, col. 9, lns. 11-14, col. 10, lns. 43-48, and col. 11, lns. 38-51). In Lahat, the scheduler selects which queue to transmit based on any desired scheduling scheme. One example is to use a round robin technique giving equal preference to each queue. (See Lahat, col. 9, lns. 64-66)

Thus, neither Shively nor Lahat disclose (i) buffering data units of the converted data streams into <u>queues for each input/output pair of the optical switch</u> and (ii) changing the schedule of the optical switch to have unbalanced periods in response to unbalance in traffic with <u>the switch schedule being changed in response to information regarding the number of reordered data units in the queues for each input/output pair</u>.

For at least these reasons, claims 1, 13 and 25 are novel and non-obvious and thus are patentable.

Furthermore, by virtue of at least their dependency to claims 1 and 13, dependent claims 2-8, 11, 14-20, and 23 are also patentable.

New Claim 26

New claim 26 is similar to claim 1 except that claim 26 is limited to an embodiment of the invention in which the reordering units are coupled to the inputs of the optical switch. Such an embodiment is illustrated in Fig. 2.

Claim 1 covers embodiments of the invention in which the reordering units are coupled to either the inputs or the outputs of the optical switch. For example, claim 1 reads on the embodiments of Figs. 2 and 3. In Fig. 3, the position of the optical switch 114 and the time slot interchangers 111 are reversed. (See Fig. 3; specification, page 9, line 22 through page 10, line 2).

CONCLUSION

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS, P.C.

By Todd Gerety

Todd A. Gerety
Registration No. 51,729
Telephone: (978) 341-0036
Facsimile: (978) 341-0136

Concord, MA 01742-9133
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